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Oil Spill Clean Up and Recovery of Ecosystems

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Introduction

Crude oil is a fossil fuel that is found under the ocean floor in reservoirs. Oil is extracted and can be transported by ships, trucks, and pipes. Subsequently, oil spills occur from those modes of transportation breaking. For example, a pipeline bursting then oil then leaks into the body of water. Marine life is greatly impacted by the oil spills. Oil contains many toxins that can cause death or serious injury in marine animals. Ecosystems are negatively impacted due to many deaths in marine life that are important for the ecosystem's survival. Specific ecosystem services that are damaged are fisheries, suitable living environments for flora and fauna, and reliable water sources. Assessing and addressing an oil spill as soon as possible is important because the longer oil remains in an environment, the more damage it causes. Figure 1 shows the pathway in which oil spills should be addressed.

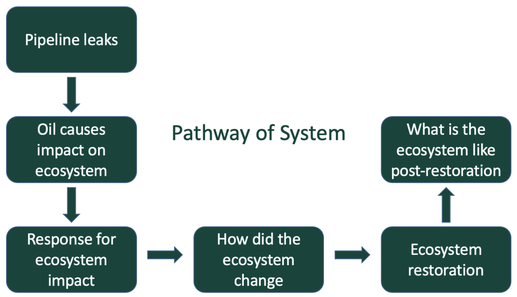

Figure 1: The system pathway in an oil spill situation.

Current Methods

There are a variety of ways to clean up oil spills since there is not one kind of spill. This is due to the nature of the spill, type of oil, location, and the climate types. Because of these variations, there are several methods used with several techniques and sub-methods to accomplish them:

- Protection: booms, sorbents, dykes, and dams. This method is displayed in Figure 2.
- Removal: booming with skimming devices, dispersants, sinking agents, sinking, burning, and bioremediation
- Restoration: replacement of sediment, revegetation, and removal of barriers that were put in place
- No-Clean Up: the spill is left alone as is when cleaning up could cause more damage. This could be likely in areas of fast flowing water.

Even though these methods are viable options that are currently used, they all have some degree of a negative impact on the ecosystem from cleaning up the spill. So, while oil harming the environment is being removed, more damage can be inflicted in the process.

Figure 2: The figure displays a boom being used to contain the surface of an oil spill.

Most Sensitive Unit

Within this system, the most sensitive unit is the recovery of ecosystems after an oil spill. In the event of an oil spill, the response is typically conducted in three steps:

- containment,
- clean up
- Restoration/recovery

The main-focus is usually on containment and clean up only. Ecosystems naturally have levels of petroleum hydrocarbons present, so when cleaning up an area after a spill, the goal of that clean up is to return the levels of petroleum hydrocarbons back to a level that has no impact on the ecosystem. Once this level is achieved, the recovery process can begin.

Types of Recovery

When recovering an ecosystem after an oil spill, there are two components that need to be addressed:

- Human Resources
- Biological

Human resources are usually addressed first and are recovered the fastest. These resources include

- beaches
- fisheries
- other places for recreational activity.

Once these are fully functioning, the recovery process will stop, and the biological component will not be addressed. The biological component of the process is the ecosystem recovery.

Ecosystem Recovery

The recovery of an ecosystem is characterized by re-establishing a biological community in which the flora and fauna can fully function. This can take between 2-10 years because recovery time depends on many environmental factors surrounding the spill and when the organisms will return to the ecosystem. The amount of time it takes for an ecosystem to recover in relation to environmental factors can be seen in Figure 3.

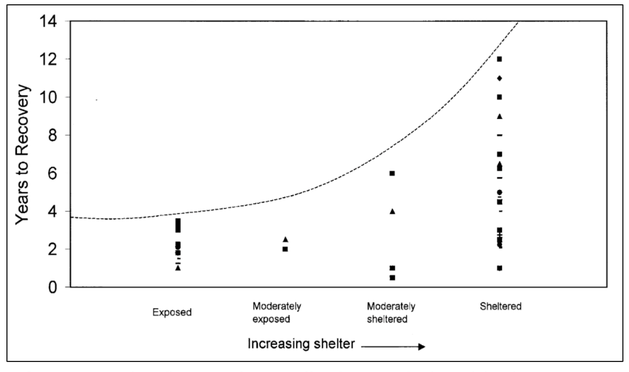

Figure 3: The figure above displays relationship between the amount of shelter over an ecosystem and the number of years it takes for an ecosystem to recover from an oil spill.

Along with recovery time having much variation, the state to which an ecosystem returns to after an oil spill is unpredictable as well. This is also due to environmental and climate factors, as well as how many organisms will return to the environment. Because of these variabilities, the success of the recovery of an ecosystem can be determined by:

- How well the ecosystem can function
- How much life has returned to the ecosystem

Reintroduction of Species

Once the petroleum hydrocarbon levels have been reduced to a suitable level for the ecosystem, the recovery process can begin. When recovering an ecosystem after an oil spill, there are two steps in which the process can be approached:

- Making the environment suitable again for organisms to live
- Adding the organisms back into the environment.

To make the environment suitable again, this could focus on oxygen levels in an ecosystem. Oil spills reduce oxygen levels by blocking light from reaching phytoplankton species. When this happens, photosynthesis stops, phytoplankton species die, and oxygen levels reduce. Reintroduction of phytoplankton populations is important so organisms dependent on oxygen can safely follow. The relationship between these species and the way oxygen is transmitted is displayed in Figure 4.

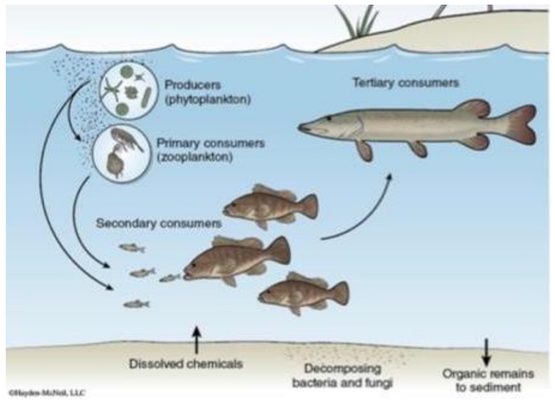

Figure 4: The figure above displays relationship between phytoplankton producing oxygen and organisms consuming it.

Adding Organisms Back into the Environment

One key component of introducing a species into a new environment is limiting the stress and shock of the transition. This is done by

- Matching donor environment to new environment
  - ❖ One way this can be achieved is by integrating organisms from nearby environments into the recently recovered one
- Proper handling of organisms during transport
- Releasing the new species into the environment during stable phases of climate cycle (no high/low temperatures or high-water flow rate)

Organisms have intrinsic factors that increase their probable success rate in a new ecosystem [4], including

- High frequency of breeding
- Parent protection of offspring
- High genetic variation of population
- Previous population exposure to chemicals/toxins found in new ecosystem
- Advanced mate finding strategies

Organisms that do not meet these categories have been found to have low survivability rates and should not be initially chosen as part of species introduction to a recovering ecosystem. Given this, it is important to prioritize introducing organisms that meet these factors to have a higher success rate of the recovered ecosystem.

Research

Hypothesis: Reintroducing species into an ecosystem will help aid an ecosystem to full recovery after an oil spill.

Objective: To help ecosystems return to a state of full functionality after an oil spill.

Task:

1. Clear the oil from the environment
2. Prepare the ecosystem for organisms to return
3. Reintroduce suitable species into the environment

Data Analysis Techniques:

- Collect data on the levels of petroleum hydrocarbons in the environment
  - ❖ The WHO limits the concentration of polycyclic hydrocarbons to 50 ng/L
- Measure the oxygen levels in the water of the ecosystem
  - ❖ Most fish species can live in water with a dissolved oxygen level between 5-12 mg/L
- Analyze if the ecosystem can function on its own, meaning can it support the flora and fauna
  - ❖ This includes having food resources to support life, light resources for flora, etc. It is important to ensure these natural processes can occur.
- Lastly, when fully functioning, collect data on how much life has permanently returned to the ecosystem

With this research, it can highlight what will work in the long run when recovering an ecosystem after an oil spill. Figure 5 below displays the type of data that could be collected from this research.

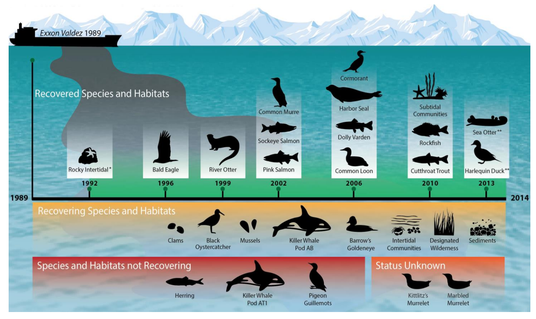

Figure 5: The figure above displays the status of species recovering after the Exxon Valdez Oil Spill.

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